Orleans were observed on the morning of the 5th. On the 14th an area of high pressure appeared north of Montana. It gradually spread southward and eastward reaching the middle Mississippi Valley by the morning of the 16th, the Texas Coast by the morning of the 17th, and the north Atlantic Coast during the 18th. The temperature gradients in front of the advancing cold were rather steep and the advent of colder weather was marked by sharp squall winds with rain, sleet, or snow. While there were no severe cold waves during the month, there were frequent alternations from warm to cold, or from rain to snow and sleet.

The mean temperatures and the departures from the normal, as determined from records of the maximum and minimum thermometers, are given in Table I for the regular stations of the Weather Bureau, which also gives the height of the thermometers above the ground at each station. The mean temperature is given for each station in Table II, for voluntary observers.

The *monthly mean temperatures* published in Table I, for the regular stations of the Weather Bureau, are the simple means of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to Table II. The mean temperatures given in Table III for Canadian stations are the simple means of 8 a. m. and 8 p. m. simultaneous observations.

The *regular diurnal period* in temperature is shown by the hourly means given in Table V for 29 stations selected out of 82 that maintain continuous thermograph records.

The *distribution of the observed monthly mean* temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart IV; the lines are drawn over the Rocky Mountain Plateau region, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the country occupied by our observers; such isotherms are controlled largely by the local topography, and should be drawn and studied in connection with a contour map.

The *years of highest and lowest mean temperatures* for December are shown in Table I of the REVIEW for December, 1894. The mean temperature for the current month was neither the highest nor the lowest on record at any regular station of the Weather Bureau at which observations have been made for a period of twenty years or more.

The *maximum and minimum temperatures* of the current month are given in Table I. The highest maxima were: 89, Los Angeles (29th); 83, Key West (3d), Jupiter (22d); 82, San Luis Obispo (30th); 80, Jacksonville (4th), San Diego (13th). The lowest maxima were: 40, Duluth (9th); 41, Idaho Falls (8th); 44, Moorhead (29th); 45, Sault Ste. Marie (9th), Moorhead (29th); 46, St. Paul, Minneapolis, La Crosse, Greenbay, and Dubuque (9th). The highest minima were: 51, Key West (28th); 49, Jupiter (29th); 40, Tampa (9th); 39, Charleston (26th), San Francisco (22d); 38, Port Eads (5th). The lowest minima were: —43, Havre (2d); —31, Miles City (3d); —26, Williston (2d); —21, Lander (16th); —20, Huron (4th).

*In Canada.*—Prof. R. F. Stupart reports:

Highest maxima: Kingston, 55; Port Dover, 58; Paris, 57; Niagara, 61; Yarmouth, 57.

Lowest maxima: Prince Albert, Qu'Appelle, Port Arthur, Father Point, 38; White River, 37; Winnipeg, 33; Minnedosa, 34.

Highest minima: Esquimalt, 29; Agassiz, 15; Halifax, 7; Yarmouth, 10; Sydney, 4.

Lowest minima: Edmonton, —42; Battleford, Prince Albert, —34; White River, —43.

The *years of highest maximum and lowest minimum temperatures* for December are given in the last four columns of Table I of the REVIEW for December, 1896. During the current month the maximum temperatures were equal to or above the highest on record at: Eastport*, 54; Vineyard Haven, 62; Pensacola, 76; Port Eads, 77; Los Angeles, 89. The minimum temperatures were equal to or below the lowest on record at: Amarillo, —1; Fresno, 23; Los Angeles, 30.

The *greatest daily range of temperature and the data for computing the extreme and mean monthly ranges* are given for each of the regular Weather Bureau stations in Table I. The largest values of the greatest daily ranges were: Havre, 68; Huron, 58; Pierre, 55; Pueblo, 51; San Luis Obispo, 49; Lander, 47; Cheyenne, 45. The smallest values were: Fort Canby, 13; Tatoosh Island, Pysht, 14; Seattle and Tacoma, 15; Astoria, 16; San Francisco and Key West, 17.

Among the *extreme monthly ranges* the largest were: Havre, 94; Miles City, 82; Rapid City, 77; Williston, Bismarck, Pierre, 75. The smallest values were: Tatoosh Island, 16; Fort Canby, 19; Port Angeles, 22; Astoria, 23; Pysht, San Francisco, 24; Seattle, 25.

*Considered by districts* the mean temperatures of the current month show departures from the normal as given in Table I. The greatest positive departures were: North Pacific, 1.1; South Atlantic and Florida Peninsula, 1.0 each. The greatest negative departures were: Upper Mississippi, 5.0; Missouri Valley, 4.8; middle Slope, 4.4; middle plateau, 4.2.

*In Canada.*—Professor Stupart says:

There was nothing especially remarkable about the distribution of mean temperature. Throughout British Columbia, the Northwest Territories, Manitoba, the Lake Superior district, northern Ontario, and northern Quebec it was a little below average, and over southern Ontario, southern Quebec, and in the Maritime Provinces it was a little above. The greatest departures reported were: 4° below average at White River, Ont., and 4° above at Chatham, N. B.

*Accumulated monthly departures from normal temperatures* from January 1 to the end of the current month are given in the second column of the following table, and the average departures are given in the third column, for comparison with the departures of current conditions of vegetation from the normal condition.

| Districts. | Accumulated departures. | | Districts. | Accumulated departures. | |
|---|---|---|---|---|---|
| | Total. | Average. | | Total. | Average. |
| | ° | ° | | ° | ° |
| New England | + 5.5 | + 0.5 | Florida Peninsula | — 0.4 | 0.0 |
| Middle Atlantic | + 4.0 | + 0.3 | Northern Slope | — 0.1 | 0.0 |
| South Atlantic | + 5.5 | + 0.5 | Southern Plateau | — 7.5 | — 0.6 |
| East Gulf | + 8.4 | + 0.7 | Middle Plateau | — 8.8 | — 0.7 |
| West Gulf | +11.0 | + 0.9 | Middle Pacific | — 5.6 | — 0.5 |
| Ohio Valley and Tenn. | + 8.6 | + 0.7 | South Pacific | — 9.0 | — 0.8 |
| Lower Lake | + 7.5 | + 0.6 | | | |
| Upper Lake | +15.9 | + 1.3 | | | |
| North Dakota | + 2.8 | + 0.2 | | | |
| Upper Mississippi Valley | + 9.7 | + 0.8 | | | |
| Missouri Valley | + 8 9 | + 0.7 | | | |
| Middle Slope | + 8.4 | + 0.7 | | | |
| Northern Plateau | + 7.8 | + 0.6 | | | |
| North Pacific | + 0.1 | 0.0 | | | |
| Southern Slope | 0.0 | 0.0 | | | |

## FROST.

At the end of the month freezing temperatures had occurred in all parts of the country, except on the immediate Pacific Coast, the delta of the Mississippi, and the Florida Peninsula. In the last-named, light to heavy and killing frosts occurred over the northern half of the peninsula in exposed places. The isotherms of 32° and 40°, on the snowfall Chart VI, show the southerly limits of the regions that have suffered frost or freezing weather.

## PRECIPITATION.

[In inches and hundredths.]

On the whole, December, 1897, was not far from a normal month as regards precipitation. There was more than the

* Observations cover a period of twenty-five years, or more.

average on the north Pacific Coast and in the lower Mississippi Valley, but there was less than the average on the middle and south Pacific Coast. The deficiency in the Gulf and South Atlantic States, referred to in previous REVIEWS, still exists.

*Considered by districts* the total precipitation, i. e., rainfall and melted snow, of the current month was normal in one, above in ten, and below in ten. The amounts above or below normal in the various districts were not large, except on the Pacific Coast, where an excess of 3.70 inches, and deficits of 3.00 and 2.20 inches, respectively, were noted. Elsewhere the excess or deficiency per district was not greatly over half an inch, as will be seen by an examination of Table I.

*In Canada.*—Prof. R. F. Stupart says:

In the southern part of Vancouver Island the precipitation was above average, but on the mainland of British Columbia, it appears to have been, on the whole, below rather than above average amount. In the Northwest Territories and Manitoba, where it was chiefly snow, it was above average almost everywhere, and especially so at Prince Albert and Winnipeg. Along the north shore of Lake Superior, in the lower St. Lawrence Valley, the Gulf, and in the Maritime Provinces, it was below the average, and in the eastern and southern portions of these latter provinces to a considerable extent, Yarmouth being 3.2 inches below, Halifax 1.9 below, and Sydney 2.2 inches below. Over the greater part of Ontario and over the extreme western part of Quebec it was above the average, Parry Sound being as much as 2.1 inches above and Montreal 2.2 above. In southern Ontario, generally, it was nearly average, but locally, in the southwestern portion, there appears to have been a small deficiency.

The *average departure* for each district is given in Table I. By dividing each current precipitation by its respective normal the following corresponding percentages are obtained (precipitation is in excess when the percentage of the normal exceeds 100):

Above the normal: New England, 119; middle Atlantic, 119; south Atlantic, 103; east Gulf, 114; west Gulf, 124; Ohio Valley and Tennessee, 117; Missouri Valley, 140; northern Slope, 147; northern Plateau, 110; north Pacific, 140.

Normal: Florida Peninsula, 100.

Below the normal: Lower Lake, 86; upper Lake, 91; North Dakota, 38; upper Mississippi, 95; middle Slope, 67; southern Slope, 49; southern Plateau, 32; middle Plateau, 82; middle Pacific, 46; south Pacific, 11.

The *years of greatest and least precipitation* for December are given in the REVIEW for December, 1890. The precipitation for the current month was the greatest on record at: Narragansett Pier, 6.70; Cheyenne,* 1.27; Port Angeles, 9.85. It was the least on record at: Minneapolis, 0.13; Oklahoma, 0.70; Fresno, 0.48; Los Angeles, 0.05.

The *total accumulated monthly departures* from January 1 to the end of the current month are given in the second column of the following table; the third column gives the current accumulated precipitation expressed as a percentage of its normal value.

| Districts. | Accumulated departures. | Accumulated precipitation. | Districts. | Accumulated departures. | Accumulated precipitation. |
|---|---|---|---|---|---|
| | *Inches.* | *Per ct.* | | *Inches.* | *Per ct.* |
| New England | + 0.90 | 102 | Middle Atlantic | — 3.50 | 93 |
| Florida Peninsula | +11.30 | 122 | South Atlantic | — 4.70 | 91 |
| Middle Slope | + 0.30 | 101 | East Gulf | — 5.30 | 90 |
| Southern Plateau | + 3.20 | 138 | West Gulf | —10.50 | 76 |
| Northern Plateau | + 2.50 | 115 | Ohio Valley and Tenn. | — 1.30 | 97 |
| North Pacific | + 3.00 | 105 | Lower Lake | — 3.90 | 89 |
| Middle Plateau | 0.00 | 100 | Upper Lake | — 3.10 | 91 |
| | | | North Dakota | — 1.90 | 90 |
| | | | Upper Mississippi Valley | — 2.10 | 94 |
| | | | Missouri Valley | — 3.30 | 89 |
| | | | Northern Slope | — 0.30 | 98 |
| | | | Southern Slope | — 0.60 | 97 |
| | | | Middle Pacific | — 5.80 | 80 |
| | | | South Pacific | — 1.60 | 87 |

*Observations cover a period of over twenty-five years.

SNOWFALL.

The *total monthly snowfall* at each station, if any occurs, is given in Tables I and II. The geographical distribution of snowfall is shown on Chart VI. Practically no snow fell from Chesapeake Bay westward to the foothills of the Appalachians and southward to the Gulf. No reports of snow were received from a narrow fringe of country on the Pacific Coast extending from Tatoosh Island on the north to San Diego on the south, although it is quite certain that snow fell on the higher peaks and ridges of that region.

Ordinarily the southern limit of snowfall in December is found farther to the southward than is the case for the current month. The total depth of snowfall for the month is graphically shown on Chart VI by lines of equal snowfall. In drawing these lines only average depths at several stations in the same locality are considered.

SNOW ON THE GROUND AT THE END OF THE MONTH.

The depth of snow on the ground at the close of the month is shown on Chart VII.

It will be seen that the ground was covered with snow in the Rocky Mountain and Plateau regions, although the depth was not so great as on November 30. There was no snow on the ground over a narrow strip extending from Kansas northward to the British Possessions.

A heavy snowstorm prevailed throughout the upper Ohio Valley and the Middle States on the 31st and this region, as will be seen by reference to the chart, shows a greater depth of snow than is to be found elsewhere, except in isolated localities, as the upper peninsula of Michigan and at a few stations in mountainous regions.

*In Canada.*—Prof. R. F. Stupart says:

At the close of the month the only portions of the Dominion which had not a covering of snow were southern British Columbia, southern Alberta and southwestern Assiniboia, the greater part of Nova Scotia and New Brunswick near the Bay of Fundy. The snowfall in the mountains is reported as less than average, although at Glacier nearly 9 feet are reported to have fallen. In northern Cariboo it is 20 inches on the level, and at Kamloops 6 inches. At Prince Albert it is 21 inches, and at Winnipeg 12 inches.

ICE IN RIVERS AND HARBORS AT THE CLOSE OF THE MONTH.

The "Snow and Ice chart" of January 3, 1898, contains the following:

In the Missouri River ice ranges from 10 inches at Omaha to 20 inches at Bismarck and Williston, N. Dak.; in the Mississippi, from 9 inches at Hannibal to 15.5 at St. Paul, being generally from 1 to 3 inches more than reported on December 27. Considerably more ice is also reported at stations along the Great Lakes and New England. In the Mohawk River it averages 8 inches, and in the Hudson ranges from 8 inches at Glens Falls to floating ice at Poughkeepsie, the ice in both the Mohawk and Hudson being very lumpy, necessitating much planing before harvesting. In the rivers of New England the ice generally ranges from 7 to 9 inches in thickness. As compared with the corresponding date of last year there is decidedly more ice over the western sections of the country, but in the rivers of Maine there is somewhat less.

*In Canada.*—Prof. R. F. Stupart reports the following figures:

Medicine Hat and Swift Current, 16 inches; Minnedosa, 18 inches; Winnipeg, 10 inches; White River, 22 inches; Orillia, 8 inches; Arden, 8 inches; Georgetown, 6 inches; Midland, 7 inches; Parry Sound, 4 inches; Port Stanley, 6 inches; Rockliffe, 6 inches; Chatham, N. B., 9 inches; Yarmouth, 2 inches; Grand Manan, 5 inches; Charlottetown, 6 inches.

HAIL.

The following are the dates on which hail fell in the respective States:

California, 1, 14. Missouri, 17. North Carolina, 14. West Virginia, 31. Oregon, 6, 7, 8, 11.

SLEET.

The following are the dates on which sleet fell in the respective States:

Alabama, 25. Arizona, 1, 2, 8, 15, 18, 19, 20, 23. Arkansas, 2, 14, 16, 17, 18, 19, 20, 21, 25, 31. California, 4, 18. Connecticut, 17, 26. Delaware, 20, 26, Georgia, 5, 14, 25, 26. Idaho, 15. Illinois, 2, 3, 4, 5, 6, 10, 13, 14, 16, 17, 19, 20, 25, 28, 30, 31. Indiana, 1, 2, 3, 4, 5, 13, 17, 19, 20. Iowa, 3, 4, 6, 7. Kansas, 2, 3, 4, 6, 9, 12, 13, 16, 17, 18, 19, 20, 27. Kentucky, 2, 3, 4, 14, 16, 17, 18, 19, 20, 21, 24, 30, 31. Louisiana, 3, 4, 18, 19, 23, 24. Maine, 14, 21. Maryland, 3, 4, 20, 22, 26. Massachusetts, 17, 31. Michigan, 4, 5, 6, 13, 14, 20, 29, 30. Minnesota, 6, 7, 11, 15. Mississippi, 4, 17, 18, 19, 21, 25, 26, 27. Missouri, 2, 3, 4, 5, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 25, 29, 30, 31. Montana, 14, 15, 23, 25. Nebraska, 20, 27, 30. Nevada, 2, 6, 7, 8, 10, 11, 18, 19. New Hampshire, 12, 14, 21. New Jersey, 3, 4, 8, 9, 15, 20, 21, 22, 23, 26, 30, 31. New York, 4, 5, 6, 7, 13, 14, 17, 20, 26, 30. North Carolina, 20, 21, 25, 26, 29, 30, 31. North Dakota, 4, 5, 7, 11, 12, 29, 30. Ohio, 2, 3, 4, 5, 7, 17, 20, 21, 22, 25, 29, 30, 31. Oklahoma, 2. Oregon, 1, 4, 5, 9, 17, 24. Pennsylvania, 3, 4, 5, 17, 19, 20, 21, 26, 31. South Carolina, 25. South Dakota, 4, 5, 10, 12, 13. Tennessee, 2, 4, 5, 14, 15, 17, 18, 19, 20, 21, 25, 26, 31. Texas, 2, 3, 4, 16, 17, 18, 19, 20, 21. Utah, 8, 12, 14. Vermont, 14, 15, 17, 18. Virginia, 2, 19, 20, 25, 26, 27, 28, 29. Washington, 4, 15, 16, 25, 26. West Virginia, 19, 20, 29, 31. Wisconsin, 3, 4, 5, 6, 12, 13, 28.

## WIND.

The *prevailing winds* for December, 1897, viz, those that were recorded most frequently, are shown in Table I for the regular Weather Bureau stations.

The *resultant winds*, as deduced from the personal observations made at 8 a. m. and 8 p. m., are given in Table VIII. These latter resultants are also shown graphically on Chart IV, where the small figure attached to each arrow shows the number of hours that this resultant prevailed, on the assumption that each of the morning and evening observations represents one hour's duration of a uniform wind of average velocity. These figures indicate the relative extent to which winds from different directions counterbalanced each other.

*Maximum wind velocities* are given in Table I, which also gives the altitudes of Weather Bureau anemometers above the ground. Maxima of 50 miles or more per hour were reported during this month as follows (maximum velocities are averages for five minutes; extreme velocities are gusts of shorter duration, and are not given in this table):

| Stations. | Date. | Velocity. | Direction. | Stations. | Date. | Velocity. | Direction. |
|---|---|---|---|---|---|---|---|
| | | *Miles* | | | | *Miles* | |
| Amarillo, Tex. | 12 | 56 | n. | Fort Canby, Wash. | 31 | 50 | e. |
| Do. | 13 | 54 | nw. | Carson City, Nev | 6 | 57 | sw. |
| Do. | 15 | 54 | w. | Do. | 7 | 56 | w. |
| Block Island, R.I. | 14 | 54 | e. | Cheyenne Wyo | 7 | 50 | w. |
| Buffalo, N. Y | 5 | 60 | w. | Chicago, Ill | 16 | 56 | sw. |
| Do. | 16 | 51 | w. | Do. | 29 | 56 | sw. |
| Do. | 29 | 53 | w. | Cleveland, Ohio | 23 | 56 | nw. |
| Do. | 30 | 53 | w. | Do. | 24 | 50 | nw. |
| Fort Canby, Wash. | 4 | 78 | se. | Denver, Colo | 7 | 53 | w. |
| Do. | 6 | 86 | s. | Do. | 30 | 52 | w. |
| Do. | 7 | 84 | s. | Havre, Mont. | 26 | 60 | nw. |
| Do. | 8 | 63 | s. | Sioux City, Iowa. | 15 | 51 | nw. |
| Do. | 10 | 54 | se. | Do. | 16 | 53 | nw. |
| Do. | 13 | 75 | se. | Tatoosh Island, Wash. | 6 | 60 | e. |
| Do. | 23 | 60 | s. | Do. | 13 | 54 | w. |
| Do. | 24 | 59 | s. | Do. | 27 | 53 | s. |
| Do. | 25 | 60 | se. | Do. | 30 | 55 | e. |
| Do. | 26 | 72 | s. | Do. | 31 | 63 | e. |
| Do. | 27 | 72 | s. | Woods Hole, Mass. | 18 | 54 | nw. |
| Do. | 28 | 60 | s. | Do. | 24 | 50 | w. |

## ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table IX, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

*Thunderstorms.*—The dates on which the number of reports of thunderstorms for the whole country were most numerous were: 9th, 27; 10th, 24; 13th, 30.

Reports were most numerous from: Louisiana, 26; Mississippi and Missouri, 15; Oregon, 24.

Thunderstorm days were most numerous in: Alabama, Missouri, and Oregon, 5; Louisiana, 12; Mississippi, 7.

*In Canada.*—Professor Stupart reports thunderstorms as follows: at Bermuda on the 15th.

*Auroras.*—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, from the 4th to the 12th, inclusive. On the remaining twenty-two days of this month 128 reports were received, or an average of about 6 per day. The dates on which the number of reports of auroras for the whole country especially exceeded this average were: 20th, 40; 21st, 27.

Reports were most numerous from: Illinois, 11; Minnesota and Montana, 20; North and South Dakota, respectively, 10.

The number of reports was a large percentage of the number of observers in: Minnesota, 29: Montana, 54; North Dakota, 20; and South Dakota, 23.

*In Canada.*—Professor Stupart reports auroras on the following dates: Father Point, 20, 21, 28, 29; Winnipeg, 20, 31; Minnedosa, 1, 15, 17, 18, 20, 21, 22, 29; Qu'Appelle, 30, 31; Medicine Hat, 10, 20, 22, 23, 26, 28, 30; Swift Current, 22; Prince Albert, 2; Edmonton, 20; Battleford, 2, 4, 15, 29, 30, 31.

## SUNSHINE AND CLOUDINESS.

The quantity of sunshine, and therefore of heat, received by the atmosphere as a whole is very nearly constant from year to year, but the proportion received by the surface of the earth depends upon the absorption by the atmosphere, and varies largely with the distribution of cloudiness. The sunshine is now recorded automatically at 21 regular stations of the Weather Bureau by its photographic, and at 47 by its thermal effects; at one of these stations records are kept by both methods. The photographic record sheets show the apparent solar time, but the thermometric records show seventy-fifth meridian time; for convenience the results are all given in Table X for each hour of local mean time. In order to complete the record of the duration of cloudiness these registers are supplemented by special personal observations of the state of the sky near the sun in the hours after sunrise and before sunset, and the cloudiness for these hours has been added as a correction to the instrumental records, whence there results a complete record of the duration of sunshine from sunrise to sunset.

The average cloudiness of the whole sky is determined by numerous personal observations at all stations during the daytime, and is given in the column "average cloudiness" in Table I; its complement, or percentage of clear sky, is given in the last column of Table X for the stations at which instrumental self-registers are maintained.

### COMPARISON OF DURATIONS AND AREAS.

The sunshine registers give the *durations* of effective sunshine whence the durations relative to possible sunshine are derived; the observers' personal estimates give the percentages of *area* of clear sky. These numbers have no necessary relation to each other, since stationary banks of clouds may obscure the sun without covering the sky, but when all clouds have a steady motion past the sun and are uniformly scattered over the sky, the percentages of duration and of area agree closely.